is temporarily written into memory until transmitted back to the control station at the time of the next shot.

Ensuring that the units are sufficiently powered has also heretofore been a concern. Many prior art patents have focused on techniques and mechanisms for powering up sensors during data acquisition/recording and powering down the sensors during dormant periods.

A land-based system representative of the prior art is taught in U.S. Pat. No. 6,070,129, which pertains to the compression and distribution of seismic data from a plurality of acquisition units, each unit being suited to acquire, to temporarily store and to compress the data for distributed transmission to a central control and recording station. Each acquisition unit is hard wired to a plurality of distributed seismic geophones/receivers from which the acquisition unit receives data. Each acquisition unit is also disposed to receive operation instructions from the central control and recording station. In one embodiment of the invention, during acquisition of data from a particular shot, partial data from the previous shot is transmitted to the central control and recording station to permit a quality control check and to ensure that the acquisition units are properly working. Data from any given shot may be distributed and transmitted over multiple transmission channels and during successive transmission windows to lessen variation in data flow.

Each of the referenced prior art devices embodies one or more of the drawbacks of the prior art. One drawback to these prior art systems is the need to activate and deactivate the units for recording and operation, including data and quality control transmission. For land-based systems, this generally requires a control signal transmitted via a cable or radio signal from the dog house. However, external control may be undesirable since it requires signal transmission and additional components in the system. Of course, any type of control signal cabling for transmission of electrical signals is undesirable because it adds a level of complexity to the handling and control of the unit and requires external connectors or couplings. Such cabling and connectors are particularly susceptible to leakage and failure in extreme environments, whether the corrosive environment of transition zone water or the high temperature, corrosive environments of the desert.

A similar problem exists with units that utilize external electrical wiring to interconnect distributed elements of the unit, such as is taught in U.S. Pat. No. 5,189,642 and similar devices where the geophone package is separate from the electronics package. Furthermore, to the extent the electronics of a system are distributed, the likelihood of malfunction of the system increases.

Many of the prior art systems also use radio telemetry rather than recording data on-board the unit, to collect the data. Such systems, of course, have limitations imposed by the characteristics of radio transmission, such as radio spectrum license restrictions, range limitations, line-of-sight obstructions, antenna limitations, data rate limitations, power restrictions, etc.

Thus, it would be desirable to provide a land-based seismic data collection system that does not require external communication/power cabling, either from the control station or on the seismic data collection unit itself between unit components. Likewise, the unit should record and otherwise operate without any type of external control signal. In other words, the unit should operate on a "drop and forget" basis. Likewise, the device should be easily serviced without the need to open the device to perform activities such as data extraction, quality control and power replenishment. The device should also be designed to withstand the corrosive, extreme environments which are often encountered in seismic exploration. The device should also permit quality control data sent back by radio to determine if the remote units of the system are operating properly without the need for control signals or tying the quality control data transmission to a shot cycle.

SUMMARY

The present invention provides a land-based system for collecting seismic data by deploying multiple, continuous operating, autonomous, wireless, self-contained seismic recording units or pods Seismic data previously recorded by the pod can be retrieved and the pod can be charged, tested, re-synchronized, and operation can be re-initiated without the need to open the pod.

More specifically, the unit is self-contained such that all of the electronics are disposed within or on the case, including a geophone package, a seismic data recording device and a clock. A power source is either contained within the case, or may be attached externally to the case. The clock may be attached to a gimbaled platform having multiple degrees of freedom to minimize the effects of gravity on the clock.

In one embodiment of the invention, the clock is a rubidium clock. The rubidium clock is much less susceptible to temperature or gravitational effects or orientation of the unit.

In another embodiment, the unit includes a crystal clock and the crystal clock is corrected for the effects of aging on the crystals.

The power source is preferably rechargeable batteries disposed within the unit's case that can operate in a sealed environment, such as lithium ion batteries. Alternatively, the power source may incorporate a fuel cell or solar cell attached to the unit's case.

The self-contained seismic units may include a tilt meter within the unit's case. While tilt meter data is utilized by the invention for several different inventive functions, such as the above-mentioned crystal clock correction procedure, none of the prior art seismic units have incorporated a tilt meter within a seismic unit comprising a single, self-contained package. Rather, such prior art units have separate attached packages housing the separate components. For example, a prior art unit may have one package that houses a tilt meter while a separate package houses a geophone.

Of course, a tilt meter may also be used to determine the vertical orientation of a unit so that corresponding seismic data can be correct accordingly. One aspect of the invention is to obtain and utilize tilt meter data in a time continuous fashion. Prior art units typically determine a unit's vertical orientation using means external to said case and orientation data are generated therefrom only once at the beginning of seismic recording. To the extent orientation corrections have been made to seismic data acquired with such prior art units, the corrections are based only on the initial orientation of the unit. Yet it has been observed that the orientation of a seismic unit may change over the course of deployment as the unit is subject to external forces which have been known to range from water currents to kicking by cows. Thus, in the invention, vertical orientation data is measured by the tilt meter as a function of time so that seismic data can be correspondingly corrected.

With respect to corrections for tilt, timing or similar data that could effect the accuracy of the collected seismic data, all of the prior art devices make such corrections at a processing center. None of the prior art devices make such corrections on-board the unit while it is deployed. Thus, one method of the invention is to make such corrections on-board the unit while it is deployed.